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13. ABSTRACT *(Maximum 200 words)*

THIS REPORT IS A SUMMARY OUTLINING EFFORTS IN THE AREA OF CARBON TREATMENT OF GROUND WATER DURING 1979. THE FOLLOWING OBSERVATIONS AND STUDIES WERE INVOLVED: (1) A REQUIREMENT TO EVALUATE THE NORTH BOUNDARY TREATMENT SYSTEM WAS ESTABLISHED WHEN HIGHER RATE OF CARBON USAGE THAN ANTICIPATED WAS ENCOUNTERED DURING THE TREATMENT OF NORTH BOUNDARY GROUND WATER, (2) A STUDY WAS INITIATED TO DETERMINE THE ABILITY OF REGENERATED CARBON TO EXTRACT CONTAMINANTS FROM THE GROUND WATER IN THE ABSENCE OF A MULTI-MEDIA PREFILTER, (3) A COMPARISON STUDY WAS MADE BETWEEN THE CAPACITY OF REGENERATED CARBON TO REMOVE DIMP FROM THE NORTH BOUNDARY GROUND WATER VERSUS THE CAPACITY OF REGENERATED CARBON TO REMOVE DIMP FROM SELECTED WELL WATERS AS OBSERVED IN THE ORIGINAL 1977 PILOT STUDY, (4) OBSERVATIONS WERE MADE FOR THE BREAKTHROUGH OF SECONDARY CONTAMINANTS THROUGH THE CARBON BED, (5) A SINGLE CARBON COLUMN SIMILAR TO THE COLUMNS USED IN THE ORIGINAL PILOT STUDY WERE INSTALLED SLIP-STREAM TO THE FULL SCALE CALGON SYSTEM TO EVALUATE THESE FACTORS, (6) COMPARISON STUDIES WERE MADE

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DEPARTMENT OF
ROCKY MOUNTAIN
COMMERCE CITY, COLO

81321R06
ORIGINAL

SARRM-TOE-C

5 February 1980

SUBJECT: Carbon Treatment of Groundwater

Commander
US Army Toxic and
Hazardous Materials Agency
ATTN: DRXTH-IR, Don Campbell
Aberdeen Proving Ground, MD 21010

1. Per telecon between Carl Loven (RMA) and Don Campbell (USATHAMA) inclosed is a summary report outlining this organization's efforts in the area of carbon treatment of groundwater during 1979.

2. As you can see from the results, some objectives were not achieved due to experimental error and the extended length of time required to conduct this type of test. However, in most cases sufficient data was generated to confirm previous assumptions and to provide a needed degree of confidence as applied to future north boundary design efforts. The experience gained in the design and operation of this type of experimental design will enhance future testing programs.

FOR THE COMMANDER:

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F/ IRWIN M. GLASSMAN
Director of Technical Operations

Summary of 1979 Carbon Adsorption Studies of North Boundary Contaminated Groundwater

INTRODUCTION

1. A requirement to evaluate the North Boundary Treatment System was established when higher rate of carbon usage than anticipated was encountered during the treatment of north boundary groundwater.

✓ 2. A study was intiated to determine the ability of regenerated carbon to extract contaminants from the groundwater in the absence of a multi-media prefilter.

✓ 3. A comparison study was made between the capacity of regenerated carbon to remove DIMP from the north boundary groundwater versus the capacity of regenerated carbon to remove DIMP from selected well waters as observed in the original 1977 pilot study.

✓ 4. Observations were made for the breakthrough of secondary contaminants through the carbon bed.

5. A single carbon column similar to the columns used in the original pilot study was installed slip-stream to the full scale Calgon system to evaluate these factors.

6. Comparison studies were made for the capacity of regenerated carbon to various hydraulic loadings in the downflow mode.

CONCLUSIONS

1. The carbon usage rates for single column and original pilot study were both 1.1 lb carbon/1000 gallons wastewater. This compares to 1.93 lb carbon/1000 gallon wastewater (cycle 1) and 1.30 lb carbon/1000 gallon wastewater (cycle 2) of the Calgon adsorbers which confirms results indicated in the Calgon report - annual technical review FY 1979.

2. Although the reactivated carbon performed very well without the multi-media prefilter, it is recommended that a multi-media prefilter continue to be on-line as no assurance can be made that suspended solids would remain in the low range. An increase in suspended solids would reduce the efficiency of the carbon, causing more frequent bed changes.

3. The DIMP loading on 15# regenerated carbon and the original 30 lb regenerated carbon were similar at 1.1 lb carbon/1000 gallon wastewater, clearly indicating that resident time of the wastewater in carbon is essential to contminant removal.

Incl

4. The second contaminant that could be identified to breakthrough the carbon bed was Dithiane after processing 21,835 gallons of wastewater. A GC/MS revealed a peak MW162 after processing 19,500 gallons of wastewater. The peak has not been identified to date. Since DIMP was the first contaminant to breakthrough the carbon bed, DIMP should still be the primary indicator to determine the carbon bed life.

DIMP breakthrough @ gallons

5. Although the data from the increased hydraulic loadings to the carbon bed was erratic, the data indicates that additional adsorbers would be required to assure proper resident time plus verifying that air entrapment in the carbon bed lowers the carbon efficiency. A study of an upflow configuration is recommended for higher hydraulic loadings to a carbon bed eliminating the air entrapment problem.

TABLE 1

REGENERATED CARBON CAPACITY

DIMP LIMIT	LB CARBON	GALS WATER TREAT	GAL/LB	LBS/1000 GAL
50	15	12,066	804	1.24
500	15	13,854	924	1.08
50	30	21,600	720	1.38
500	30	27,400	913	1.09
50	20,000 Cycle 1	792,000	396	2.52
500		10,330,484	517	1.93
50	20,000 Cycle 2	12,625,761	631	1.58
500		15,432,261	772	1.30

DISCUSSION

The influent water was pumped directly from the North Boundary Treatment Plant feed sump at a controlled rate downflow through the adsorber to attain a resident time of 30 minutes. Equipment for the column study consists of 5 inch dia X 6 feet long plastic column, 15 lbs or regenerated calgon carbon on top of 3" bed of mulit-size stone, pressure gauge, and pressure control regulator.

The adsorption study was conducted to evaluate the adsorptive capacity of reactivated carbon in removing DIMP from the north boundary water versus the adsorptive capacity of reactivated carbon in the earlier study of DIMP removal from wastewater derived from selected wells.

Data from the analyses are shown in the appendix. (Table A1) A graphical presentation of DIMP data is shown in Figure 1 in the form of breakthrough curves. These curves were plotted using data from the influent and effluent versus volume of wastewater treated; therefore, the curves represent and adsorption treatment of 30 minutes.

The DIMP breakthrough curves indicate that the original 30 lb carbon bed pilot study treated approximately 12500 gallons more wastewater than the 15 lb carbon bed. However, on a lbs of carbon/1000 gallon water processed indicates simular DIMP removal capacity, as shown in Table 1.

The Table indicates a 50 ppb and a 500 ppb limit, with the lower limit signalling a warning to prepare for a carbon bed change.

Table 1, also, shows the large 20,000 lb carbon adsorber capacity for two cycles. The results confirm the calgon findings that air entrapment is occuring in the carbon bed lowering the carbon efficiency.

The elimination of the multi-media prefilter apparently had no effect on the carbon capacity to adsorb DIMP. This may be attributed to the low suspended solids (20 ppm) in the wastewater. Since a potential suspended solids increase could occur, it is recommended to maintain a multi-media prefilter (see Table 1).

A secondary contaminant was determined to be Dithiane (7.3 ppb) after 21,835 gallons of processed wastewater. Also, a peak MH162 was observed on a GC/MS after processing 19,500 gallons of wastewater. The laboratory is currently investigating the identification of this unknown peak.

TABLE 2

DIMP Limit	Hydraulic loading (Gals/Min/Sq. Ft.)	Gal Water Treat	Gal/lb	Lbs/1000 gal
50	2.1	2100	140	7.10
500	2.1	2900	193	5.18
50	2.55	2625	175	5.71
500	2.55	7400	493	2.03
50	3.18	9100	607	1.65
50	3.82	500	33	30.3
500	3.82	5800	387	2.58

DISCUSSION

An auxiliary adsorption study was performed to evaluate the adsorptive capacity of reactivated carbon in removing DIMP from the north boundary water at hydraulic loadings of 2.1, 2.55, 3.18, and 3.82 gals/min/sq ft.

Data for the analyses are shown in the appendix (Table A2). A graphical presentation of DIMP data is shown in Figure 2 in the form of breakthrough curves. These curves were plotted using data from the average influent and effluent versus volume of wastewater treated.

The DIMP breakthrough curves indicate an erratic hehavior at the higher flow rates. These results may be attributed to the observed air entrapped throughout the carbon beds lowering the DIMP removal efficiency. Table 2 reflects the erratic behavior on a lbs of carbon/1000 gallon water processed.

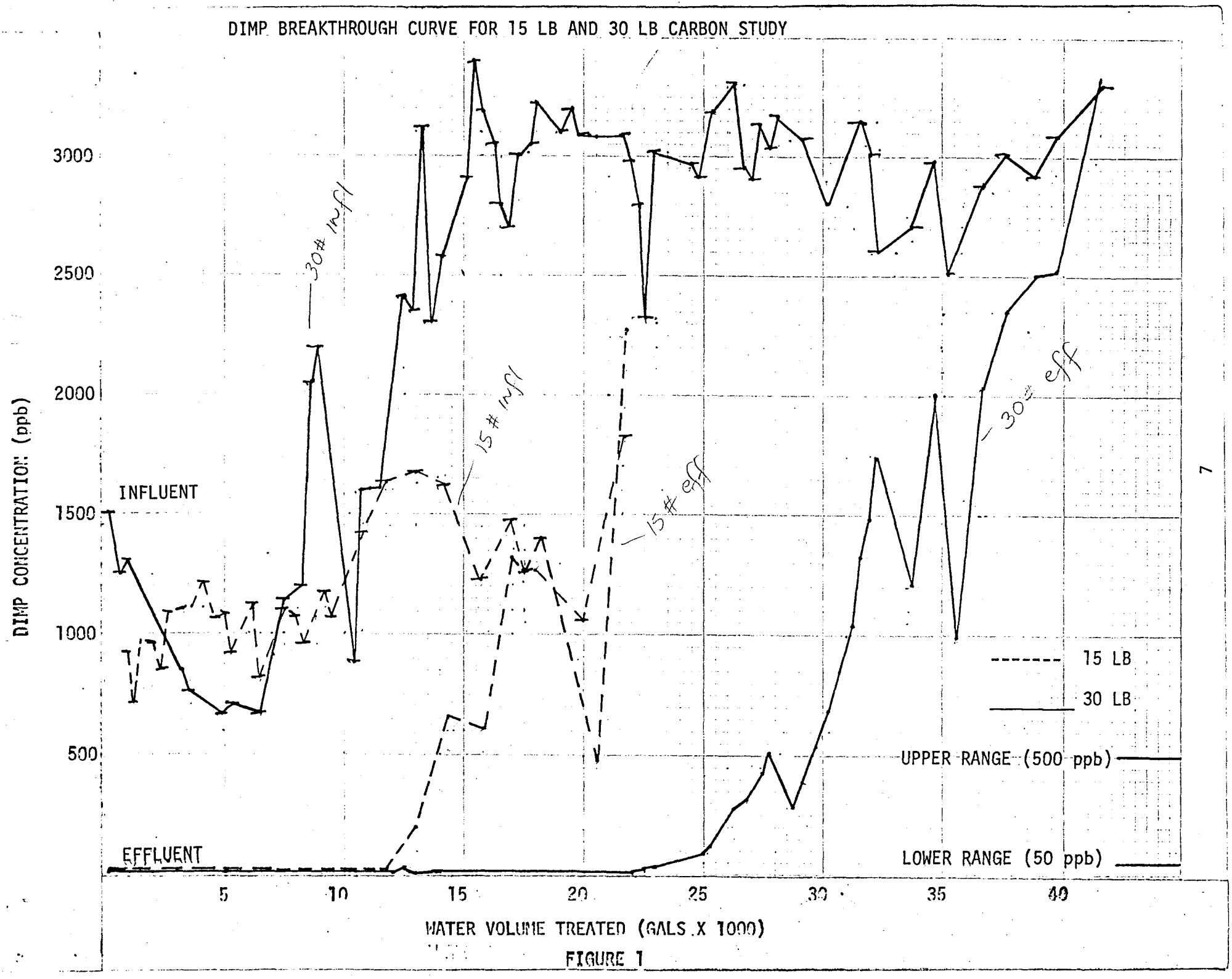
DIMP BREAKTHROUGH CURVE FOR 15 LB AND 30 LB CARBON STUDY
DIMP CONCENTRATION (ppb)
3000
2500
2000
1500
1000
500
INFLUENT
EFFLUENT
30# infl
15# infl
15# eff
30# eff
15 LB
30 LB
UPPER RANGE (500 ppb)
LOWER RANGE (50 ppb)
5
10
15
20
25
30
35
40
WATER VOLUME TREATED (GALS X 1000)

FIGURE 1

DIMP BREAKTHROUGH CURVE FOR VARIOUS HYDRAULIC LOADS

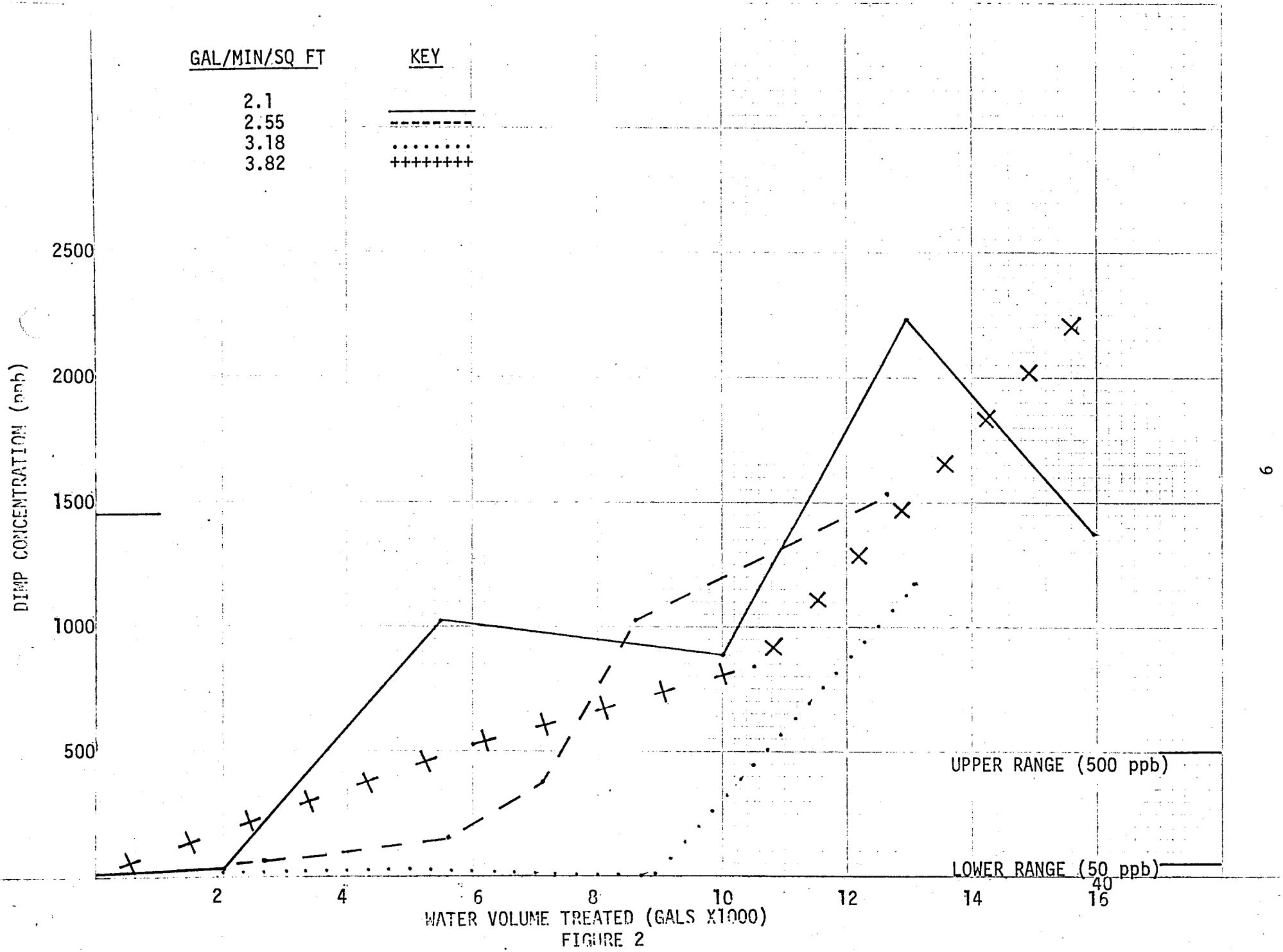

FIGURE 2

APPENDIX

TABLE A1

REACTIVATED CARBON TEST RESULTS - DIMP (ppb)
(30 MINUTE RESIDENT TIME)

1977
(30 LBS CARBON)

DATE	INFLUENT	EFFLUENT	CUML FLOW (GAL)
1/25	1510	0.5	360
1/26	1250	0.5	720
1/28	1300	0.8	1440
2/2	850	1.3	3240
2/3	762	0.8	3600
2/4	737	0.5	3960
2/7	678	0.5	5040
2/8	705	1.1	5400
2/9	681	0.8	5760
2/10	678	0.5	6120
2/11	680	0.5	6480
2/14	1149	0.7	7560
2/15	1158	0.5	7920
2/16	1202	9.5	8280
2/17	2067	0.5	8640
2/18	2229	0.7	9000
2/22	885	1.2	10440
2/23	1591	2.2	10800
2/24	1585	0.8	11160
2/25	1656	0.5	11520
2/28	2413	12.7	12600
3/1	2361	3.1	12960
3/2	3109	4.2	13320
3/3	2317	1.3	13680
3/4	2589	2.1	14040
3/7	2941	1.3	15120
3/8	3434	1.9	15480
3/9	3198	2.4	15840
3/10	3065	0.3	16200
3/14	2800	1.2	16560
3/15	2713	0.4	16920
3/16	3005	1.3	17280
3/17	3070	1.2	17640
3/18	3227	1.5	18000
3/21	3106	2.2	19080
3/22	3230	1.3	19440
3/23	3098	1.7	19800
3/24	3080	1.2	20160
3/25	3068	1.2	20520
3/28	3092	2.1	21600
3/29	2994	5.4	21960
3/30	2807	7.3	22320
3/31	2331	19.4	22680

1979
(15 LBS CARBON)

DATE	INFLUENT	EFFLUENT	CUML FLOW (GAL)
2/20	933	2.3	1063
2/21	743	< 2	1224
2/22		± 2	1421
2/23	975	< 4	1607
2/26	920	3.1	2152.5
2/27	-	< 2	2295
2/28	855	< 2	2474
3/1	-	< 2	2651
3/2	1095	< 2	2837
3/5	1110	< 2	3375
3/7	1133	< 2	3736
3/9	1205	< 2	4096
3/12	1074	< 2	4632
3/13		< 2	4815
3/14	1090	< 2	5000
3/16	915		5375
3/21	1126	< 2	6263
3/23	823	< 2	6623
3/26	916	< 2	7168
3/28	1113	< 2	7520
3/30	1065	< 2	7867
4/2	961	< 2	8423
4/4	1078	< 2	8807
4/6	1170	5.02	9188
4/6	PLANT DOWN TO 4/16		
4/18	1086	< 2	9588
4/25	1425	< 2	10869
4/30	1630	< 2	11749
5/7	1667	200	13016
5/14	1635	664	14312
5/23	1236	610	15895
5/29	1472	1323	17012
6/1	1266	1259	17516
6/4	1277	1409	18073
6/18	1062	482	20605
6/25	1821	2275	21835*

*Second Contaminant Breakthrough
Dithiane 7.3 ppb

1977
(30 LBS CARBON)

DATE	INFLUENT	EFFLUENT	CUML FLOW (GAL)
4/1	3035	37	23040
4/4	UNITS DOWN		
4/6	2991	31.4	24570
4/7	2908	96.6	24930
4/8	3199	127	25290
4/11	3323	284	26340
4/12	2957	312	26700
4/13	2919	326	27060
4/14	3143	438	27400
4/15	3044	510	27760
4/18	3180	290	28840
4/19	3080	391	29190
4/21	2783	546	29820
4/22	2820	693	30180
4/25	2737	1043	31260
4/26	3149	1338	31620
4/27	3039	1489	31980
4/28	2611	1743	32340
5/2	2711	1213	33780
5/5	2992	2000	34860
5/6	COLUMNS DOWN		
5/12	2514	997	35310
5/16	2874	2141	36750
5/19	3014	2354	37830
5/24	2920	1504	38980
5/26	3086	1518	39700
5/31	3312	3327	41500

Table A2
Reactivated Test Results-DIMP (ppb)
(Various Hydraulic Loads)

DATE	Hydraulic Load (Gals/Min/Sq Ft)	Effluent (ppb)	Cum Flow (Gal)
5/7	2.1	20.9	2016
5/14		1036	5509
5/23		895	10002
5/29		2242	12996
6/4		1376	15991
5/23	2.55	50.4	2625
5/29		161	5625
6/1		384	7124
6/4		1022	8625
6/12		1544	12624
6/12	3.18	$8.8	5000
6/18		22	8749
6/25		1232	13124
6/12		539	5999
6/18		846	10499
6/25		2234	15748

Average Influent 1452 ppb